Inter (Part-II) 2021

Chemistry	Group-II	PAPER: II
Time: 2.40 Hours	(SUBJECTIVE TYPE)	Marks: 68

SECTION-I

2. Write short answers to any EIGHT (8) questions: (16)

(i) What do you know about period 6 of the periodic table?

Ans The period 6 is a long period, which contains thirty-two elements. In this period, there are eight representative elements, ten transition elements and a new set of fourteen elements called Lanthanides as they start after $_{57}La$. Lanthanides have remarkably similar properties and are usually shown separately at the bottom of the periodic table.

(ii) Why Na^+ is smaller than Na atom?

Ans When a neutral atom loses one or more electrons, it becomes a positive ion. The size of the atom is decreased in this process becasue of the two reasons. First, the removal of one or more electrons from a neutral atom usually results in the loss of the outermost shell and, second, the removal of electrons causes an imbalance in proton-electron ratio. Due to the greater attraction of the nuclear charge, the remaining electrons of the ion are drawn closer to the nucleus. Thus, a positive ion is always smaller than the neutral atom from which it is derived. The radius of Na is 186 pm and the radius of Na^+ is 102 pm.

(iii) What are alkali metals? Give name of alkali metals.

Ans The name alkali came from Arabic, which means 'The Ashes'. The Arabs used this term for these metals because they found that the ashes of plants were composed chiefly of sodium and potassium. Alkali metals include the elements, lithium, sodium, potassium, rubidium, cesium and francium. These are very reactive metals, produce strong alkaline solutions with water.

(iv) Give two differences between lithium and other alkali metals.

Ans Two of the more important differences of lithium from other alkali metals are listed below:

1. Lithium is much harder and lighter than the other alkali metals.
2. The lithium salts of anions with high charge density are generally less soluble in water than those of the other alkali metals, *e.g.*, LiOH, LiF, Li_3PO_4, Li_2CO_3.

(v) Give chemical formulas of mica and bauxite.

Ans Chemical formula of mica: $KH_2Al_3(SiO_4)_3$

Chemical formula of bauxite: $Al_2O_3.2H_2O$

(vi) How would you prepare borax from colemanite?

Ans Finely powdered colemanite is boiled with Na_2CO_3 solution, when $CaCO_3$ precipitates out and a mixture of borax and sodium metaborate is formed.

$$\underset{\text{Colemanite}}{Ca_2B_6O_{11(s)}} + 2Na_2CO_{3(aq)} \longrightarrow 2CaCO_{3(s)} + Na_2B_4O_{7(s)} + 2NaBO_{2(s)}$$

The clear solution from the top is taken off and is then allowed to crystallize, when crystals of borax separate out. To get more borax, CO_2 is blown through the mother liquor, the sodium metaborate is decomposed into borax, which separates out in the form of fine crystals.

$$\underset{\text{Sodium metaborate}}{4NaBO_{2(s)}} + CO_{2(g)} \longrightarrow Na_2CO_{3(s)} + \underset{\text{Borax}}{Na_2B_4O_{7(s)}}$$

(vii) Give two uses of aluminium.

Ans Following are two uses of aluminium:

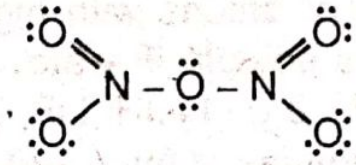
1. Aluminium is very light (nearly three times less dense than iron) but possesses high tensile strength. These properties account for its extensive use in the transport industries, in the construction of aircrafts, ships and cars.
2. It is an excellent conductor of both electricity and heat. Thus, it is used as heat exchanger in chemical, oil and other industries. Heavy duty electrical cables are made of aluminium metal.

(viii) Draw structural formulas of dinitrogen pentoxide and dinitrogen oxide.

Ans $[N = N = O \longleftrightarrow N \equiv N - O]$

Dinitrogen Oxide, N_2O

(Nitrous oxide)



Dinitrogen pentoxide, N_2O_5
(Nitric anhydride)

(ix) "Sulphuric acid is a dehydrating agent". Justify.

Ans H_2SO_4 has a great affinity for water, so it acts as dehydrating agent and eliminates water from different compounds.

With oxalic acid, it forms CO_2 and CO.

$$\begin{matrix}COOH \\ | \\ COOH_{(aq)}\end{matrix} \xrightarrow{\text{Conc. } H_2SO_4} CO_{2(g)}CO_{(g)} + H_2O_{(l)}$$

(x) Write different steps involved in the manufacturing of urea.

Ans Urea is produced by the reaction of liquid ammonia with gaseous carbon dioxide. Following steps are involved in the manufacture of urea:

(i) Preparation of Hydrogen and carbon dioxide
(ii) Preparation of Ammonia
(iii) Preparation of Ammonium Carbamate
(iv) Preparation of Urea
(v) Concentration of Urea
(vi) Prilling

(xi) Why potassium fertilizers are important for plants?

Ans These fertilizers provide potassium to the plant or soil. Potassium is required for the formation of starch, sugar and the fibrous material of the plant. They increase resistance to diseases and make the plants strong by helping in healthy root development. They also help in ripening of seeds, fruits and

cereals. Potassium fertilizers are especially useful for tobacco, coffee, potato and corn.

(xii) What reactions take place between 1 to 7 days during setting of cement?

Ans Tricalcium silicate ($3CaO.SiO_2$) and tri-calcium aluminate ($3CaO.Al_2O_3$) get hydrolyzed to produce calcium hydroxide and aluminium hydroxide. The calcium hydroxide, thus formed, starts changing into needle-shaped crystals, which get studded in the colloidal gel and impart strength to it. Aluminium hydroxide, on the other hand, fills the interstices resulting in hardening the mass. The gel formed starts losing water partly by evaporation and sets to a hard mass.

3. Write short answers to any EIGHT (8) questions: (16)

(i) Write any two uses of bleaching powder.

Ans Bleaching powder is used:

(i) for the laboratory preparation of chlorine and oxygen. It is also used in the manufacture of chloroform.

(ii) as a disinfectant and in the sterilization of water.

(ii) What is disproportionation reaction? Give one example.

Ans A reaction in which a species (molecule, atom or ion) is simultaneously oxidized and reduced, is called a "disproportionation reaction".

The reactions of chlorine with hot and cold NaOH are examples of "Disproportionation reactions".

$$Cl_2 + 2NaOH \xrightarrow{\text{cold}} NaCl + NaClO + H_2O$$

$$3Cl_2 + 6NaOH \xrightarrow{\text{hot}} 5NaCl + NaClO_3 + 3H_2O$$

(iii) Why HF is weaker acid than HCl?

Ans Hydrofluoric acid is a weak acid due to limited ionization. The other three acids are very strong acids. The acidic strength increases in the order:

$$HF < HCl < HBr < HI$$

(iv) Why does damaged tin plated iron get rusted quickly?

Ans If the protective coating is damaged, then iron comes into contact with moisture. A galvanic cell is established in which tin acts as a cathode and iron as an anode. The electrons flow

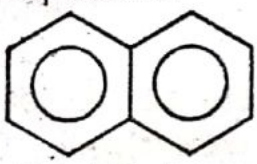
from iron to tin, where they discharge H^+ ions, leaving behind OH^- in the solution. These hydroxide ions react with iron forming $Fe(OH)_3$, which dissolves rapidly in water. From this, it can be concluded that plated iron gets rust more rapidly when the protective coating is damaged than the non-plated iron.

(v) Give the prevention of metals from corrosion.

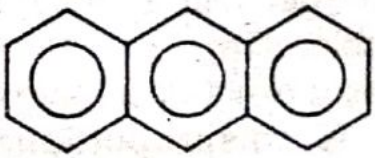
Ans Different methods are used to prevent corrosion. The simplest of them consists of protecting the surface of the metal from coming in direct contact with the surrounding by coating it with oil, paint, varnish or enamel. It can also be prevented by alloying the metals or by coating the metal with a thin layer of another metal.

(vi) What are polycyclic aromatic hydrocarbons? Give examples.

Ans The aromatic compounds may also contain more than one benzene rings fused together, which are called polycyclic aromatic compounds.



Naphthalene



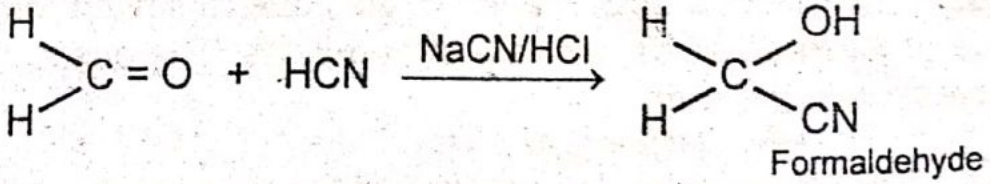
Anthracene

(vii) What infromation do we get from X-ray study of benzene?

Ans The X-ray studies of benzene have confirmed the hexagonal structure for it. These studies have also revealed that all the carbon and hydrogen atoms are in the same plane. All the angles are of 120°. All C – C and C – H bond lengths are 1.397 A and 1.09 A, respectively.

(viii) How does formaldehyde react with the following reagent: (a) HCN (b) $NaHSO_3$.

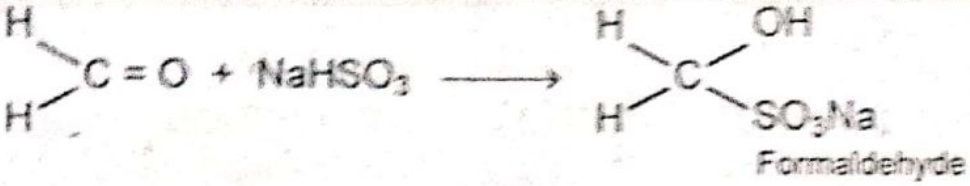
Ans **(a) Reaction with HCN:**



Formaldehyde

Formaldehyde cyanohydrin

(b) Reaction with $NaHSO_3$:



Formaldehyde

Bisulphite addition protect

(ix) How will you distinguish between methanal and ethanal?

Ans Ethanal can give iodoform test while methanal does not give.

$$CH_3-\overset{\overset{O}{\|}}{C}-H + 3I_2 + 4NaOH \longrightarrow CHI_3 + HCOONa + 3NaI + 3H_2O$$

Ethanal — Iodine — Iodoform — Sod. formate

$$H-\overset{\overset{O}{\|}}{C}-H + I_2 + NaOH \longrightarrow \text{No reaction}$$

Methanal

(x) Write any two reactions of carboxylic acids in which hydrogen atomof carboxylic group is involved.

Ans Carboxylic acids are weaker acids than mineral acids. They furnish H^+ when dissolved in water.

$$R-\overset{\overset{O}{\|}}{C}-O-H \overset{H_2O}{\rightleftharpoons} R-\overset{\overset{O}{\|}}{C}-O^- + H^+$$

Carboxylate ion — Proton

In the presence of water (H_2O), the proton breaks away as H_3O^+ ion.

1. Reactions with Bases:

Carboxylic acids react with bases (NaOH, KOH) to form salts.

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

2. Reactions with Carbonates and Bicarbonates:

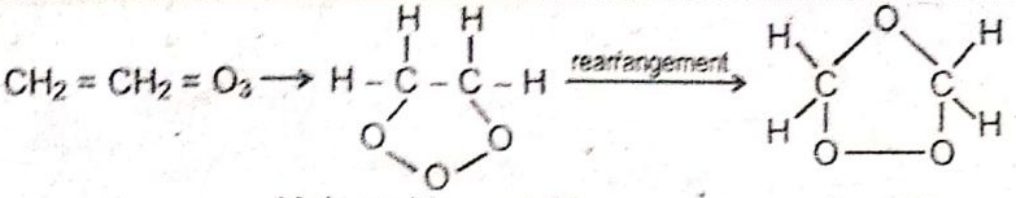
Carboxylic acids decompose carbonates and bicarbonates evolving carbon dioxide gas with effervescence.

$$2CH_3COOH + Na_3CO_3 \longrightarrow 2CH_3COO\overset{-}{\overset{+}{Na}} + CO_2 + H_2O$$

(xi) What is meant by oxidative cleavage of alkenes? Give an example.

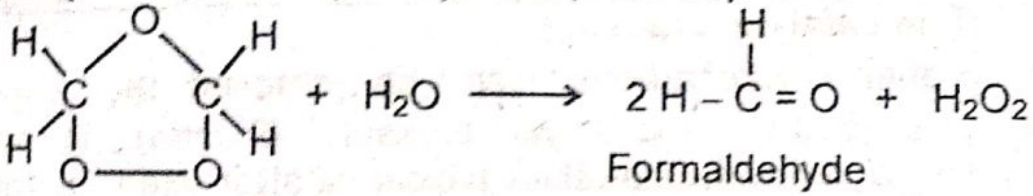
Ans A reaction in which carbon-carbon double bond of alkene is cleaved, with simultaneous oxidation of the carbons that had formed the carbon-carbon bond is called oxidative cleavage of alkenes.

Alkenes to form unstable molozonide. It rearranges spontaneously to form an ozonide.



Molozonide unstable Ozonide

Ozonides are unstable compounds and are reduced directly by treatment with zinc and H_2O. The reduction produces carbonyl compounds (aldehydes or ketones).



Formaldehyde

$$H_2O_2 + Zn \longrightarrow ZnO + H_2O$$

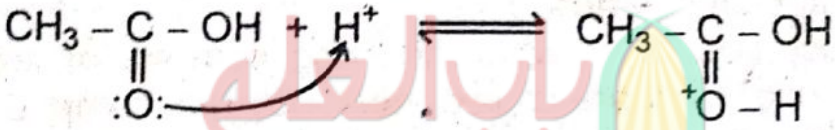
(xii) Write down the mechanism of ester formation.

Ans $CH_3COOH + C_2H_5OH \overset{H_2SO_4}{\rightleftharpoons} CH_3COOC_2H_5 + H_2O$

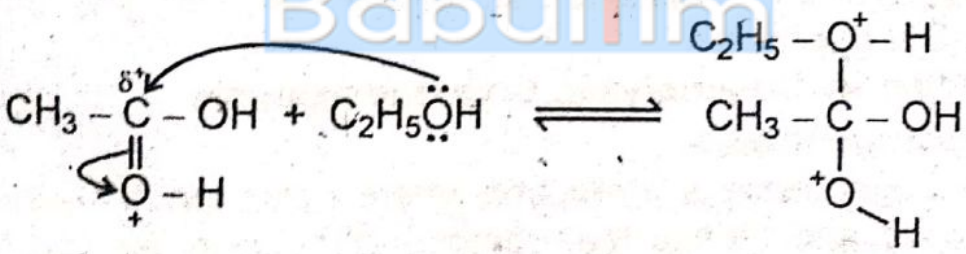
Mechanism

The various steps of the above reaction are as follows:

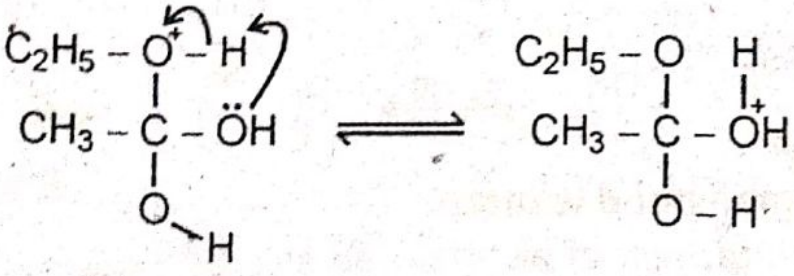
(i) Protonation of Carboxylic Acid



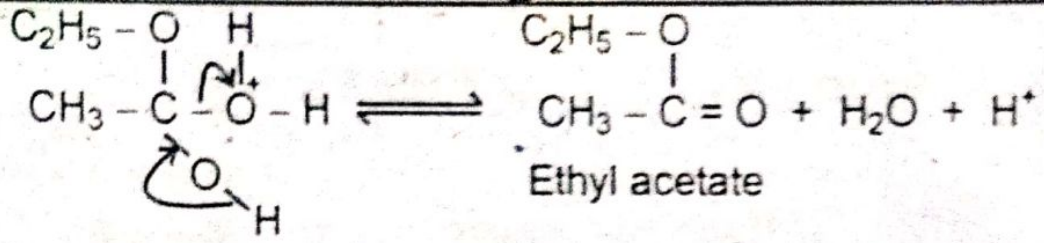
(ii) Attack of CH_3CH_2OH



(iii) Hydrogen Ion Transfer



(iv) Elimination of Water and H^+



4. Write short answers to any SIX (6) questions: (12)

(i) Define catalytic cracking.

Ans Higher hydrocarbons can be cracked at lower temperature (500°C) and lower pressure (2 atm), in the presence of a suitable catalyst. A typical catalyst used for this purpose is a mixture of silica (SiO_2) and alumina (Al_2O_3). Catalytic cracking produces gasoline of higher octane number and, therefore, this method is used for obtaining better quality gasoline.

(ii) Define homocyclic and heterocyclic compounds.

Ans Homocyclic or Carbocyclic Compounds:

The compounds in which the ring consists of only carbon atoms are called homocyclic or carbocyclic compounds.

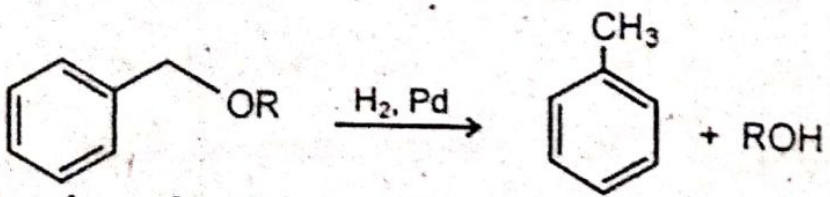
Heterocyclic Compounds:

The compounds in which the ring consists of atoms of more than one kind are called **heterocyclic** compounds or **heterocycles**. In heterocyclic compounds, generally one or more atoms of elements such as nitrogen (N), oxygen (O) or sulphur (S) are present.

(iii) Define hydrogenolysis. Give one example.

Ans Hydrogenolysis:

Hydrogenolysis is a reaction where hydrogen is added to a compound and breaks that compound's bonds, forming two molecules as a result.



(iv) Why sigma bond is inert?

Ans The un-reactivity of alkanes can also be explained on the basis of inertness of a σ-bond. In a σ-bond, the electrons are very tightly held between the nuclei which makes it a very

stable bond. A lot of energy is required to break it. Moreover, the electrons present in a σ-bond can neither attack on any electrophile nor a nucleophile can attack on them. Both these facts make alkanes less reactive.

(v) How are cis and trans alkenes prepared from alkyne?

Ans Controlled hydrogenation of alkynes with hydrogen gas in an equimolar ratio over heated catalysts, gives alkenes. The catalyst is finely divided palladium supported on $BaSO_4$ and poisoned by treatment with quinoline (Lindlar's catalyst).

$$R-C\equiv C-R + H_2 \xrightarrow[\text{Quinoline}]{Pd(BaSO_4)} \underset{\text{cis-alkene}}{\overset{R}{\underset{H}{}}C=C\overset{R}{\underset{H}{}}}$$

A trans alkene can be obtained by treating an alkyne with Na in liquid NH_3 at $-33^\circ C$.

$$R-C\equiv C-R + 2[H] \xrightarrow[-33^\circ C]{Na/\text{liquid } NH_3} \underset{\text{trans-alkene}}{\overset{R}{\underset{H}{}}C=C\overset{H}{\underset{R}{}}}$$

(vi) How are tetra ethyl lead and tetra methyl lead prepared?

Ans Methyl chloride and ethyl chloride react with sodium lead alloy giving tetramethyl lead and tetraethyl lead, respectively.

$$4CH_3Cl + Na_4Pb \longrightarrow (CH_3)_4Pb + 4NaCl$$

Tetramethyl lead

$$4CH_3CH_2 - Cl + Na_4Pb \longrightarrow (CH_3CH_2)_4Pb + 4NaCl$$

Tetraethyl lead

(vii) Differentiate between electrophile and nucleophile.

Ans **Electrophile:** It is a specie which attracts electrons (electron loving). The carbon atom of an alkyl group attached with the halogen atom and bearing a partial positive charge is called an electrophile or electrophilic center. An electrophile may be neutral or positively charged.

Nucleophile: Nucleophile means nucleus loving. It has an unshared electron pair available for bonding and, in most cases, it is basic in character. It may be negatively charged or neutral.

(viii) What is denaturing of alcohol?

Ans Sometimes ethanol is denatured by addition of 10% methanol to avoid its use for drinking purposes. Such alcohol is called methylated spirit. A small quantity of pyridine or acetone may also be added for this purpose.

(ix) Write uses of ethanol.

Ans Ethanol is used as a solvent, as a drink and as a fuel in some countries. Moreover, it is used in pharmaceutical preparations and as a preservative for biological specimens.

SECTION-II

NOTE: Attempt any Three (3) questions.

Q.5.(a) Discuss the position of hydrogen in group I-A of the periodic table. **(4)**

Ans **Analogy of Hydrogen:**

With Group IA:

Although it is not a metal but in most of the modern versions of periodic table, hydrogen is placed at the top of the group IA. This is because of the fact that some of the properties of hydrogen resemble with those of alkali metals. Like alkali

metals; hydrogen atom has one electron in 1s subshell which it can lose to form H^+. Both hydrogen and alkali metals have a strong tendency to combine with electronegative elements such as halogens. Similar to alkali metals, hydrogen also forms ionic compounds, which dissociate in water. However, hydrogen is also markedly different from alkali metals. For example, hydrogen is a nonmetal in true sense. It does not lose electron as easily as most of the alkali metals do. Unlike alkali metals, molecular hydrogen exists in open atmosphere.

(b) Describe with diagram the manufacture of sodium by Down's cell. (4)

Ans Most of sodium metal is produced by the electrolysis of fused sodium chloride. Since the melting point of sodium chloride is 801°C, some calcium chloride is added to lower its melting point and to permit the furnace to operate at about 600°C.

In the electrolytic cell, the large block of graphite at the centre is the anode, above which there is a dome for the collection of chlorine. The cathode is a circular bar of copper or iron which surrounds the anode but is separated from it by an iron screen, which terminated in a gauze. The arrangement permits the electric current to pass freely but prevents sodium and chlorine from mixing after they have been set free at the electrodes.

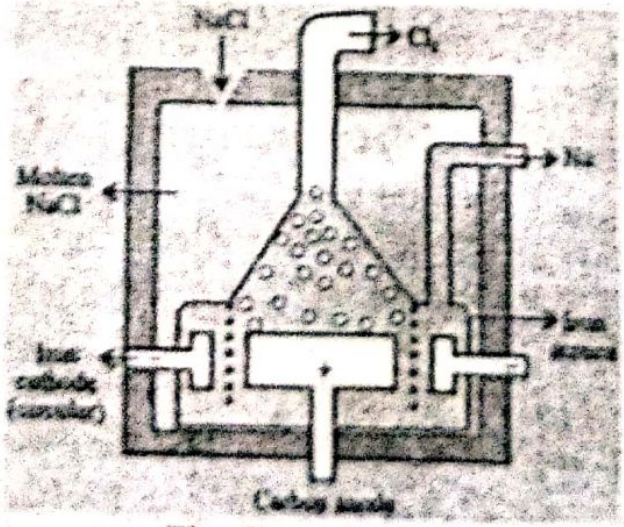


Fig. Down's Cell

Sodium metal rises in a special compartment from which it is taken out at intervals. The cell produces dry chlorine and 99.9 percent pure sodium. The process is carried out at 600°C and it has the following advantages:

(a) The metallic fog is not produced.
(b) Liquid sodium can easily be collected at 600°C.
(c) Material of the cell is not attacked by the products formed during the electrolysis.

During the process, the following reactions take place:

$$NaCl_{(s)} \longrightarrow Na^{+}_{(\ell)} + Cl^{-}_{(\ell)}$$

At cathode

$$Na^{+}_{(\ell)} + e^{-} \longrightarrow Na_{(\ell)}$$

At anode

$$Cl^{-}_{(\ell)} \longrightarrow \frac{1}{2} Cl_{2(g)} + 1\ e^{-}$$

Q.6.(a) What is corrosion? How iron metal can be prevented from corrosion? (4)

Ans Corrosion:

Any process of chemical decay of metals due to the action of surrounding medium is called corrosion.

The simplest case of corrosion occurs when metals come into contact with gases of the atmosphere. The surface of metals becomes coated with compounds such as oxides, sulphides and carbonates. Such compounds sometime form a compact layer on the surface protecting the metal from further attack.

The case would be different when the metal is in contact with water. The compounds formed in this case may dissolve in water, allowing the corrosion to penetrate further into the metal. Besides dissolving the compounds, water also promotes electrochemical process which is one of the main causes of rapid corrosion.

(b) Give the reactions of HNO_3 (dil) with the following metals: (4)

(i) Hg (ii) Cu (iii) Sn (iv) Zn

Ans (i) $6Hg + 8HNO_3\ (dil.) \longrightarrow 3Hg_2(NO_3)_2 + 2NO + 4H_2O$

(ii) $3Cu + 8HNO_3\ (dil.) \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$

(iii) $4Sn + 10HNO_3\ (dil.) \longrightarrow 4Sn(NO_3)_2 + NH_4NO_3 + 3H_2O$

(iv) $4Zn + 10HNO_3\ (dil.) \longrightarrow 4Zn(NO_3)_2 + N_2O + 5H_2O$

Q.7.(a) Define organic compounds. Give any three features of organic compound. (4)

Ans Organic chemistry is that branch of chemistry which deals with the study of compounds of carbon and hydrogen (hydrocarbons) and their derivatives.

Following are some features of organic compounds:

(1) Peculiar Nature of Carbon

Carbon forms a large number of compounds. There are millions of organic compounds known at present. The main reason for such a large number of compounds is its unique property of linking with other carbon atoms to form long chains or rings. This self-linking property of carbon is called **catenation**. Carbon also forms stable single and multiple bonds, with other atoms like oxygen, nitrogen, sulphur, etc. It can thus form numerous compounds of various sizes, shapes and structures.

(2) Non-ionic Character of Organic Compounds

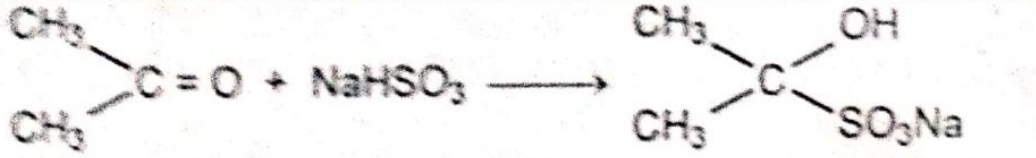
Organic compounds are generally covalent compounds, therefore, do not give ionic reactions.

(3) Similarity in Behaviour

There exists a close relationship between different organic compounds. This is exemplified by the existence of homologous series. This similarity in behaviour has reduced the study of millions of compounds to only a few homologous series.

(b) Explain with mechanism the addition of sodium bisulphate to acetone. (4)

Ans Reaction of Sodium Bisulphate with Acetone:



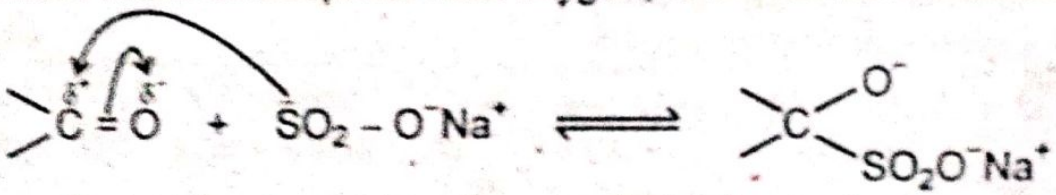
Acetone

Bisulphite addition product

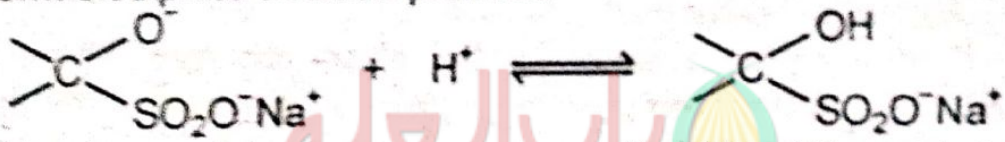
Mechanism:

Sodium bisulphite ionises to form sulphite ions.

The sulphite ion acts as a nulceophile, since the sulphur atom is more nucleophilic than oxygen, a C – S bond is formed.



Proton is attached to the negatively charged oxygen atom to form bisulphite addition product.



Bisulphite addition product

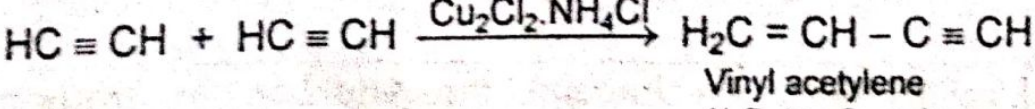
Q.8.(a) Write note on polymerization of alkynes. (4)

Ans Polymerization:

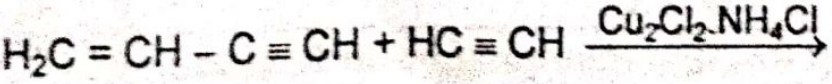
Alkynes polymerize to give linear or cyclic compounds depending upon the temperature and catalyst used. However, these polymers are different from the polymers of the alkenes as they are usually low molecular weight polymers.

1. Conversion of Acetylene to Divinyl Acetylene:

When acetylene is passed through an acidic solution of cuprous chlorine and ammonium chloride and then allowed to stand for several hours at room temperature, vinyl acetylene and divinyl acetylene are obtained.



Vinyl acetylene
(1-Buten-2-yne)



$$H_2C = CH - C \equiv C - CH = CH_2$$

Divinyl acetylene
(1,5-Hexadiene-3-yne)

If HCl is added to vinyl acetylene, chloroprene is obtained which readily polymerizes to neoprene, used as synthetic rubber.

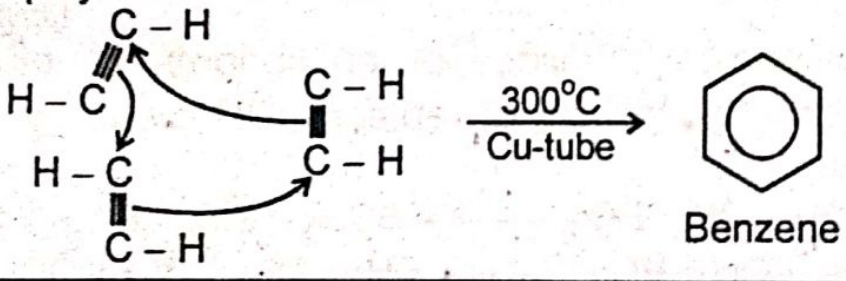
$$H_2C = CH - C \equiv CH + Conc.HCl \xrightarrow{Cu_2Cl_2.NH_4Cl} H_2C = CH - \underset{\displaystyle Cl}{\overset{|}{C}} = CH_2$$

Chloroprene

$$\text{Chloroprene} \xrightarrow{\text{Polymerization}} \text{Neoprene (synthetic rubber)}$$

2. Conversion of Acetylene to Benzene:

When acetylene is passed through a copper tube at 300°C, it polymerizes to benzene.



Benzene

(b) Give all methods for the preparation of alkyl halides. **(4)**

Ans Methods of Preparation of Alkyl Halides:

Alkyl halides can be prepared by the halogenation of alkanes and by the addition of halogen acids to alkenes. These methods have already been discussed in the previous chapters. The best method for the preparation of alkyl halides is from alcohols.

1. From Alcohols:

(a) Reaction of alcohols with halogen acids.

Alcohols may be converted to the corresponding alkyl halides by the action of halogen acid in the presence of $ZnCl_2$ which acts as a catalyst.

$$CH_3CH_2 - OH + HX \xrightarrow[H^+]{ZnCl_2} CH_3CH_2 - X + H_2O$$

Ethyl halide

(b) Alcohols also react with thionyl chloride in pyridine as a solvent to give alkyl chlorides. This method is especially useful since the by-products (HCl, SO_2) are gases, which escape leaving behind the pure product.

$$ROH + SOCl_2 \xrightarrow{\text{Pyridine}} R-Cl + SO_2 + HCl$$

Ethyl halide

(c) Phosphorus trihalides or phosphorus pentahalides react with alcohols to replace –OH group by a halo group.

$$3CH_3-CH_2-OH + PBr_3 \longrightarrow 3CH_3-CH_2-Br + H_3PO_3$$

$$CH_3-CH_2-OH + PCl_5 \longrightarrow CH_3-CH_2-Cl + POCl_3 + HCl$$

2. An excellent method for the preparation of simple alkyl iodide is the treatment of alkyl chloride or alkyl bromide with sodium iodide. This method is particularly useful because alkyl iodides cannot be prepared by the direct iodination of alkanes.

$$RCl + NaI \longrightarrow RI + NaCl$$

$$RBr + NaI \longrightarrow RI + NaBr$$

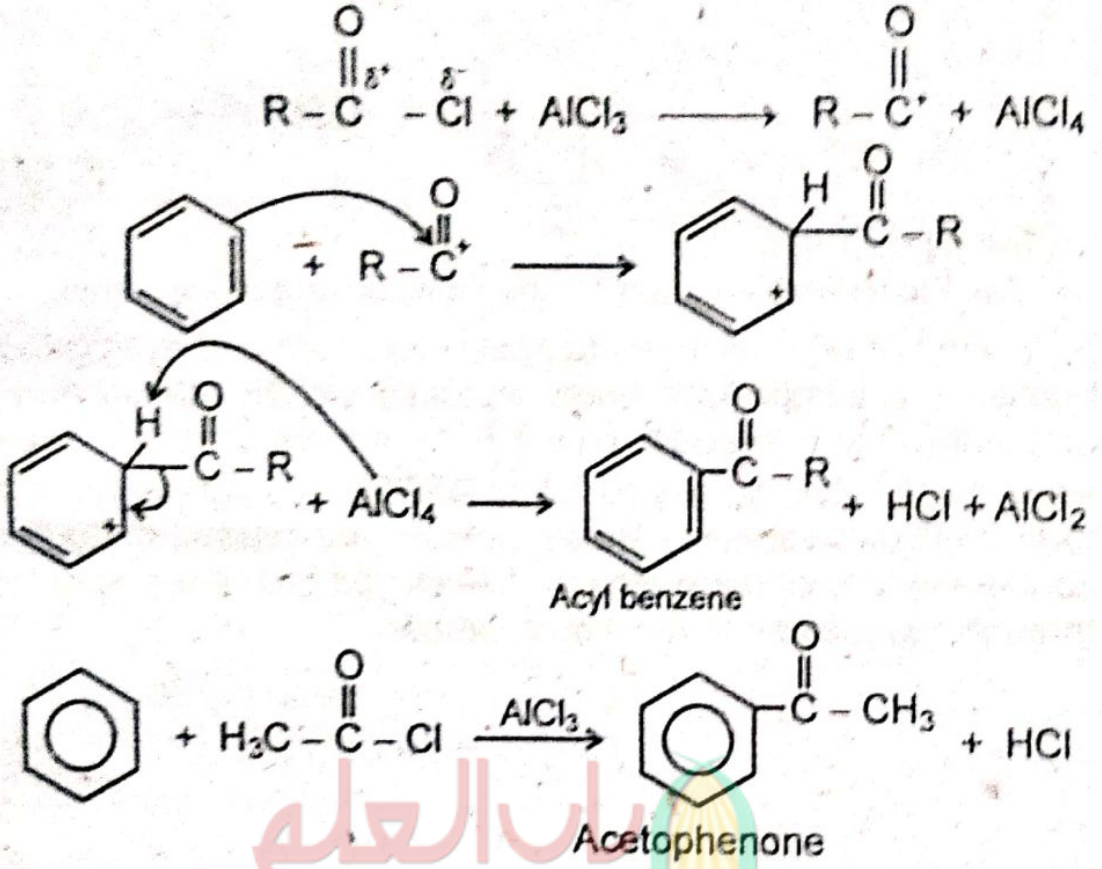
Q.9.(a) What are Friedel-Crafts reactions? Give an example and mechanism of Friedel-Crafts Acylation. (4)

Ans Friedel-Crafts Reactions:

The alkylation and acylation of benzene are called Friedel-Crafts reactions.

Acylation:

The introduction of an acyl group $R-\overset{O}{\overset{\|}{C}}-$ in the benzene ring in the presence of an acyl halide and a catalyst $AlCl_3$ is called Friedel-Crafts Acylation or Acylation.



(b) Explain with diagram the industrial preparation of methanol. **(4)**

Ans **Methanol:**

Formerly methanol was prepared by distillation of wood. That is why it is also called as wood spirit. Nowadays methanol is prepared from carbon monoxide and hydrogen or water gas as follows:

$$CO + 2H_2 \xrightarrow[450^\circ C;\ 200\ atm]{ZnO + Cr_2O_3} CH_3OH$$

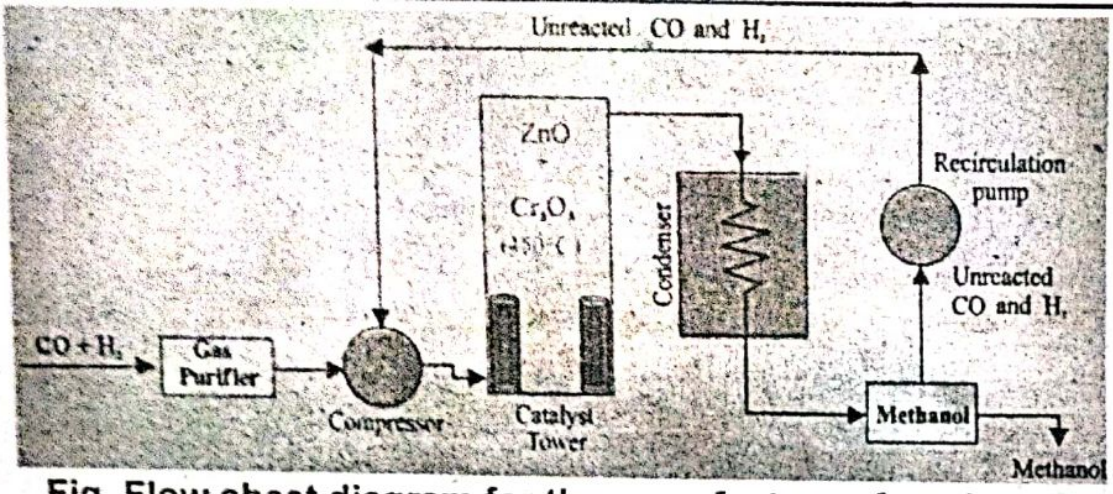


Fig. Flow sheet diagram for the manufacture of methanol.

First of all, a mixture of carbon monoxide and hydrogen is purified. It is compressed under a pressure of 200 atmospheres and taken into a reaction chamber by means of coiled pipes. Here the catalyst is heated up to 450-500°C. Gases react to form methanol vapours. These vapours are passed through a condenser to cool the methanol. Unreacted gases are recycled through compressor to reaction chamber.